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EXPERIMENT STATION WORK.

Edited by W. H. Beal and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. True, Director, Office of Experiment Stations.

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ILLUSTRATIONS.

EXPERIMENT STATION WORK.[a]

DISTRIBUTING MANURE AND FERTILIZERS.[b]

In a bulletin dealing with the use of fertilizers in Mississippi, E. B. Ferris, in charge of the substation at McNeill, makes, as a result of his experience, some practical suggestions of general interest regarding different methods of distributing manure and fertilizers. He states that "there are two general methods of applying fertilizers and manures—broadcast and in the drill. It is thought best to make very large applications broadcast. * * * Roughly speaking, we would say that any application of commercial fertilizers heavier than 1,000 pounds per acre would best be applied broadcast and any smaller amount in the drill."

USE OF THE MANURE SPREADER.

"A manure spreader is the best and cheapest means of handling barnyard manure, provided, of course, there is enough of this manure on the farm to justify one in investing about $100 in such a machine. These manure spreaders can be regulated to distribute uniformly almost any quantity of manure per acre, and will apply it either broadcast or in the drill. They can also be used for making heavy applications of commercial fertilizers."

PARKING.

The merits of parking as a means of distributing manure on light soils were tested at the McNeill substation in the following way:

In the fall and winter of 1902–3, 30 head of steers were penned on 5 acres of land and fed for one hundred days on cotton-seed meal and hulls. The troughs were moved at intervals so as to cause the cattle to distribute the manure as evenly as possible over the land, and several times during the feeding period the land was plowed to prevent the washing of the manure over the surface. The land being comparatively level, very little of this manure was lost, and the soil, being of a sandy nature, was not injured by the trampling of the cattle even in the wettest weather. The effect of this manure on subsequent crops has been quite marked, being practically as great in 1906 as it was in

[a] A progress record of experimental inquiries, published without assumption of responsibility by the Department for the correctness of the facts and conclusions reported by the stations.

[b] Compiled from Mississippi Sta. Bul. 99.

1903, the first year after the work was done. * * * The average yield of cotton on the unfertilized soil (at McNeill) has been 405 pounds per acre of seed cotton, while three years' results on this parked land show an average yield of 1,253 pounds per acre: the yield of cotton grown for four years continuously on the same land and fertilized with a mixture of two parts acid phosphate and one part cotton-seed meal at the rate of 300 pounds per acre has averaged 933.5 pounds of seed cotton per acre, while the average of three results with the same fertilizer on the parked land has been 1,840 pounds per acre; the yield of corn for three years has averaged 21.4 bushels more per acre on the parked land than on similar soils unmanured.

This shows that under favorable conditions of soil and climate parking may be a very cheap and efficient means of distributing manure.

USE OF THE FERTILIZER DISTRIBUTER.

"The best and most economical way of applying commercial fertilizers in the drill is by means of a fertilizer distributer." Mr. Ferris has tried and recommends a form of drill distributer looking very much like an ordinary cotton planter, which will apply practically any quantity of fertilizer per acre from 100 to 600 pounds, and costs between $4 and $5.

HAND APPLICATION.

Mr. Ferris states that while a good proportion of the fertilizers used is applied by hand, wind is likely to make this method unsatisfactory. "A cheap tin fertilizer horn about 4 feet long and costing 20 to 25 cents enables one to do this work much better and with a great deal less stooping."

WINTERKILLING OF PEACH BUDS.[a]

Winterkilling of buds is the cause of frequent and large losses in peach growing. The injury is sometimes due to the starting of the buds before danger of late spring frosts has passed or to their swelling during exceptionally warm winter periods. By inducing trees to mature buds late in the fall the buds will not finish their resting period, and so will not be likely to start in the spring until danger of frost and cold is past.

In a recent bulletin of the Missouri Station W. H. Chandler reports the results of investigations which were undertaken to ascertain the effects of severe pruning and methods of training, thinning, and cultivation on the hardiness of peach buds and to determine the relative hardiness of different varieties. The more important of these results obtained are summarized as follows:

It is well known that the vigor of growth of a peach tree can be increased by heading back, by cutting off a considerable portion of the ends of the branches in late winter or early spring when the fruit buds have all been killed.

[a] Compiled from Missouri Sta. Bul. 74.

This is an excellent treatment to enable trees to recover from injury to the wood by severe winters.

The fruit buds formed on this vigorous growth of new wood in sections north of Missouri are more liable to injury from the cold of the following winter.

The buds on this vigorous new wood, however, finish their resting period [a] later and are therefore not so readily started into growth by warm periods in winter to be killed by cold periods following.

In Missouri, especially the southern half, there is in nearly every winter warm weather to start the buds into growth to a small or large extent.

In most of Missouri, then, fruit buds on trees that have made rather a vigorous growth, caused by reasonably severe heading back or by cultivation, are the less liable to winter injury. This has been true in the Missouri Experiment Station orchard and in others during each of the last two years.

Heading back may be too severe, however, since in any year the fruit buds most likely to come through the winter safely are those at the base of the whips of new wood, and if the heading back has been too severe the growth will be so dense that no fruit buds will be formed at the base of those whips.

In the experiment station orchard the trees having the smallest percentage of buds killed were those trained to a spreading, open head, and forced by pruning and cultivation to make a vigorous growth.

The fruit on trees with spreading heads does not rot so badly as that on trees with dense heads.

The fruit on trees making rather a vigorous growth, unless the growth is too vigorous, is larger than that on trees making smaller growth. This is true except with early varieties, where a tree making a rather small wood growth bears the better fruit.

Thinning the fruit enables the tree to set more hardy fruit buds for the next crop.

In the station orchard where only one side of a tree was thinned the side not thinned had from 5 per cent to 40 per cent more of its fruit buds killed by a temperature of 6° F. below zero on February 5, 1907.

Many varieties, like the Elberta, Crawford, Golden Gate, Oldmixon, and others, the fruit buds of which are known to kill badly in Missouri, do so because they finish their resting periods early and are therefore easily pushed into slight growth on warm days in winter.

Varieties of Chinese Cling and green-twigged types (excepting the Elberta, which has more the character of the Persian race) are generally late in finishing their resting periods and are, therefore, better adapted to the Missouri climate.

The results of these experiments show that in general those treatments which induce vigorous growth of new wood, prolonging thereby the resting period of the buds, lessen the danger of winter killing. It is thus seen that good cultivation, pruning, thinning, and the like, which are commonly employed to improve the quantity and quality of fruit, also tend as a rule to lessen the danger of winter killing referred to. In pruning, however, it should be remembered that the young whips produced are more sensitive to prolonged cold in winter than harder wood, and the trees should be headed back

[a] Plants generally have resting periods, a period when without special treatment they can not be forced into growth.

only into 2-year-old wood. The Missouri experiments indicate that the purple-twigged varieties as a rule finish their resting period earlier than the green-twigged varieties, and hence are more likely to be winterkilled, and this offers a possible basis upon which to develop more resistant and safer varieties.

EFFECT OF FERTILIZERS ON THE COLOR OF APPLES.[a]

The opinion is sometimes advanced in popular articles on the subject of apple culture that the use of such fertilizers as potash and phosphoric acid will improve the color of fruit. In cases where these particular elements are seriously lacking in the soil it seems reasonable to believe that their addition in some available form will promote a better all-around development of the fruit, color included, since both of these elements are known to be important constituents of the apple. On the other hand, scientific knowledge with regard to the real value of potash or phosphoric acid, or any other fertilizer, in improving the color of fruit appears to be too limited to warrant the apple grower in resorting to commercial fertilizer as a specific treatment for that purpose.

In this connection experiments conducted at the New York State Station by S. A. Beach, and recently reported by U. P. Hedrick, are of special interest. These experiments were begun in 1893 on an orchard of 43-year-old apples on sloping upland with a medium heavy clay soil. They were completed in 1904.

> Throughout the experiments the orchard was given clean cultivation until about August 1, and was then seeded to a cover crop of oats, barley, or clover. * * * There were 94 trees in the test, representing the following varieties: Baldwin, Fall Pippin, Rhode Island Greening, Roxbury, and Northern Spy. The orchard was divided into 8 plats, 4 treated and 4 untreated. Wood ashes were applied to the treated plats at the rate of 100 pounds per tree, or 4,800 pounds per acre. During the last seven years of the experiment acid phosphate was applied at the rate of 8½ pounds per tree, or 408 pounds per acre. Calculations made from analyses of the fertilizers show that, on the average, 169 pounds per acre of actual potash were applied each year; 72 pounds of phosphoric acid from the ashes and 57 pounds from the acid phosphate; and lime at the rate of 32 pounds per tree, 1,536 pounds per acre. The amounts are in excess of the usual recommendations of these fertilizers for apples.

Yield and color of fruit were the two standards used for measuring the effects of the fertilizer. As for the increase in yield, it is reported that the results were practically negative from a financial standpoint.

With regard to color it is stated that—

> Taken as a whole, the results are disappointing. They lack uniformity and were not decided enough in a sufficient number of the twelve seasons to enable us to state that the addition of the substances applied heightened the color of

[a] Compiled from New York State Sta. Bul. 289. See also U. S. Dept. Agr., Office Expt. Stas. Rpt. 1903, p. 537.

apples under the conditions of this experiment. The effects varied not only from season to season, but varieties varied greatly in some seasons, and in others the same variety would color differently in plats receiving the same treatment. When we consider the number of factors which are known to influence color in fruit we can not assume with any degree of certainty that the results set forth above show that the addition of these fertilizers changed the color of the fruit in this experiment in any season. Thus, exposure to light; the intensity of the light; amount of foliage on the tree; the healthfulness of the foliage; the amount of stored food in the plant; soil heat; the texture of the soil—all of these, besides potash and phosphoric acid, have an influence. The relations of these factors are so intricate that it is almost impossible to separate them in an experiment like this, and especially as the differences were so slight.

A comparison of the color data with meteorological data for the twelve-year period shows that the treatment seemed to have an influence in coloring fruit only in those years when the apple did not develop well, as in 1893 and 1902; and that in other seasons, as in 1896, 1900, 1904, when climatic conditions were favorable to the development of fruit and foliage, the coloring was as nearly perfect on the untreated as on the treated plats.

It is not to be inferred from the results of this experiment that commercial fertilizers are never needed in the apple orchard, but they do appear to show that—

An orchard soil may not need potash, phosphoric acid, nor lime, even though the soil may have been cropped a half century; that in a soil which produces apples of poor color, potash and phosphoric acid may not improve the color; and that the apple does not seem to be as exhaustive of soil fertility as farm crops. The experiment suggests, as well, that to assume without definite knowledge that a tree needs this or that plant food, often leads to the waste of fertilizing material; and that in the matter of fertilizing an orchard a fruit grower should experiment for himself, since an orchard's need of fertilizer can be determined only by the behavior of the trees when supplied with the several plant foods.

RINGING HERBACEOUS PLANTS.[a]

U. P. Hedrick, O. M. Taylor, and R. Wellington recently reported from the New York State Station the results of an experiment in the ringing, or girdling, of tomatoes and chrysanthemums. This is practically a new field of investigation. The first work to be noted along this line was that of L. Daniel, a French investigator,[b] who conducted the experiment with different species of crucifers, eggplants, and tomatoes. With cabbage and Brussels sprouts the operation resulted in a more open head combined with a decrease in size. With these plants, as well as with kohl-rabi and ruta-bagas, ringing appeared not only to have no practical value, but was also detrimental to their best development. With eggplant, however, the size of the fruit was nearly doubled by ringing and was also considerably increased with tomatoes, although the flavor of the fruit was unfavor-

[a] Compiled from New York State Sta. Bul. 288.

[b] Compt. Rend. Acad. Sci. [Paris], 131 (1900), p. 1253. See also Amer. Gard., 22 (1901), No. 328, p. 245.

ably influenced. In 1901, U. P. Hedrick, in writing of an experiment conducted by one of his students in the ringing of chrysanthemums, said "that all competent judges who looked over the experiment agreed that there was an increase in size, and that the blossoms were hastened in their development.

These results were not considered conclusive, however, and were offered principally with the view of creating a greater interest along this line.

Ringing has been employed to some extent with woody fruit-bearing plants, such as the apple, the grape, and the currant, as well as with other tree fruits to a lesser degree for some time past. The outcome has been by no means uniform, and growers are usually advised to submit the practice to experiment under conditions common to their own soil, climate, etc., before making free use of it.

On the other hand, under favorable conditions, ringing has appeared "to cause unproductive plants to set fruit, to increase the size of the fruits and thereby the productiveness of the plant, and to hasten the maturity of the fruit." Work with grapes and apples along this line, in which the results appeared to be favorable, was reported by the Massachusetts Hatch Station.[b] The New York State Station also reported favorable results in some instances with grapes.[c]

With regard to the recent New York State Station experiment with tomatoes and chrysanthemums, the authors state that "if ringing would bring herbaceous plants into fruiting, increase the productiveness, and hasten the maturity of the product, as with grapes and apples, the operation would be of especial value in growing some greenhouse plants, since the qualities mentioned are essential to success in growing commercial crops under glass. It would commend itself, too, because the devitalization which eventually follows the ringing of plants would be of little consequence with most of those grown in the greenhouse, since they are grown for but one or two seasons and then discarded." Both the tomatoes and chrysanthemums were grown in the greenhouse under normal successful conditions. Several plants of the Lorillard tomato were ringed in the winter of 1905–6. The plants were trained to a single stem. "The members of one group of plants were ringed as soon as the second cluster of fruits had set; those of the second group when the fourth cluster had set. Plants in a third group were unringed. Ringing consisted of removing a five-eighths inch strip of bark, cutting through the woody tissue."

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[a] Amer. Florist, 17 (1901), p. 729.

[b] Massachusetts Sta. Bul. 1.

[c] New York State Sta. Bul. 151. See also U. S. Dept. Agr., Farmers' Bul. 105.

Several varieties of chrysanthemums were treated in practically the same manner in the autumn of 1906. The first group was ringed just as the buds appeared, the second about two weeks later, when the buds were one-third grown.

The results of the ringing as noted in various ways were disappointing. With the tomatoes the time of maturity was unaffected, the average number of fruits was reduced 18 per cent by the first ringing and 10 per cent by the second ringing, and the effect on the weight of the fruit was variable and inconsequent. Neither the color nor the flavor appeared to be altered by ringing. The foliage of the plant was somewhat more rank, although the root system apparently suffered from starvation. With the chrysanthemums the principal results noted were that "the first ringing hindered the opening of the buds in all of the varieties except one; the second ringing slightly hastened the maturity of all except one. The size of the blossoms of all the varieties was reduced and the earlier the ringing the greater the injury."

As a general result of this work the authors are of the opinion that it is very doubtful whether ringing can be made beneficial to herbaceous plants, in view of the fact that the loss to the plant is great and there seems to be little or no compensating gain.

"The deleterious effects of ringing on herbaceous plants are so marked that the query arises as to whether woody plants do not suffer in similar degree and the operation possibly cause a greater loss to the plant than is gained in the product."

POTATO SCAB.[a]

Potato scab is a well-known and widespread disease which does an immense amount of damage to the potato crop annually. Injury and consequent losses due to scab remain very large in spite of the fact that the cause and efficient methods of controlling the disease have been known for many years. The minute parasitic organism which causes the disease was discovered and described by Roland Thaxter of the Connecticut State Station in 1890, and several other stations have contributed to the working out of efficient methods of treatment of the disease. The roughened, scabby, pitted surface of potato tubers due to scab is well known practically everywhere that potatoes are grown, and the use of untreated seed and the too common practice of reserving unsalable, scabby tubers for planting has resulted in an increase rather than in a decrease of the disease in many localities.

[a] Compiled from Maine Sta. Bul. 141.

In a bulletin of the Maine Station, W. J. Morse summarizes the more important practical facts regarding the disease as follows:

Crop infection on old land may come from the soil, from the seed, or from both. On new land the source is largely from undisinfected seed. Soil conditions, the application of lime, ashes, chip dirt, etc., may favor the development of scab, but are incapable of causing it.

Alkaline soils, the use of stable manure, lime, ashes, and certain chemicals of alkaline nature favor the fungus. Acid soils and certain other chemicals are unfavorable to it.

Beets and the roots of a few other vegetables are attacked by the disease, but the fungus may persist in infected soil for several years without the presence of known host plants.

Badly infested soils should be devoted to such crops as grains, grasses, and clovers, for as long a time as possible. Fertilizers favorable to scab should be avoided and "souring" the soil by green manuring is recommended.

On clean soils, only healthy, disinfected seed tubers should be used. Manure containing uncooked scabby potatoes or refuse should be avoided, but no other precautions as to fertilizers are necessary. Clean soil may be infected by means of tools, bags, baskets, etc., which have been in contact with infected land or tubers.

Small amounts of seed are best disinfected by soaking: (*a*) Two hours in solution of one-half pint formalin to 15 gallons water, or (*b*) one and one-half hours in 2 ounces of corrosive sublimate dissolved in 15 gallons of water.

For large quantities of seed, formaldehyde gas, generated by the use of potassium permanganate, is the most practical disinfecting agent. Place seed tubers in bushel crates or shallow, slat-work bins in a tight room. For each 1,000 cubic feet of space spread 23 ounces of potassium permanganate evenly over the bottom of a large pan or pail in center of room. Pour over this 3 pints of formalin, leave room at once and allow to remain tightly closed for twenty-four to forty-eight hours.

The corrosive sublimate (a deadly poison), formaldehyde (usually sold under the name of formalin, a 40-per cent solution of formaldehyde), and the potassium permanganate can be obtained of any druggist. Corrosive sublimate costs about 15 cents per ounce, formalin, which should contain not less than 35 per cent of formaldehyde, 40 to 50 cents per pint, potassium permanganate 30 cents per pound.

Treatment is therefore neither very expensive nor difficult to apply according to the above directions. It would seem good economy to incur the small expense involved in protecting the potato crop from possible serious injury by scab and clean soils from infection by diseased seed.

EFFECTS OF ESCAPING ILLUMINATING GAS ON TREES.[a]

In a report of the Massachusetts Station, G. E. Stone calls attention to the increasing damage to shade and ornamental trees due to escaping illuminating gas.

[a] Compiled from Massachusetts Sta. Rpt. 1906, p. 180.

The increased death rate from this cause may be accounted for by the fact that gas is now more extensively used than formerly, and the larger pipes now in use, together with modifications in the methods of laying these pipes and calking, may be in part responsible for the increased leakage. At any rate, it would seem that where small pipes have been in the ground for many years with thread-joint connections there is much less leakage than where larger pipes are used, and where the calking is done with Portland or Roman cement and oakum or lead.

Even small leaks of only 2 to 3 cubic feet per day are capable of injuring trees in course of time, since the soil eventually becomes charged with gas. "Should the roots of trees happen to be near these leaks, the trees will become unhealthy, but perhaps will not die. There are hundreds of city trees affected in this manner, and gas is seldom suspected of causing their sickly condition."

There are two classes of injury which may readily be distinguished as resulting from gas poisoning: First, incipient cases; and, second, pronounced cases. In the first series we have those already alluded to as resulting from small leaks, and the ground in such cases never becomes fully charged for any considerable distance. They may not result in killing the tree directly, but cause it to be unhealthy, and there is likely to be a large amount of dead wood found on such trees annually. Occasionally a large tree may be located near a small leakage, and in such a case only a single root will be affected. Those portions of the trunk of the tree in direct connection with the leak will, however, show the effects of gas poisoning. Small leaks of this description often produce only local injury. Trees affected in this manner may suffer what is termed "general debility." * * * In severe cases of gas poisoning, such as take place where there is a large leak, the effects on a tree are very pronounced, and there is absolutely no hope of recovery for a tree which has once been severely injured by gas; in short, where a tree has been defoliated, or even half defoliated, from the effects of gas, there is no hope for it, although it might be possible, if one could dig up all the soil around it and expose it to the air, to eliminate much of the gas in the soil, in which case the tree might make some attempt to recover.

The characteristic symptoms of gas poisoning are quite marked to one familiar with them, and can generally be distinguished from other kinds of injury which are likely to affect a tree. It requires, however, pretty close observation and thorough understanding of conditions in order to distinguish gas poisoning from some other types of injury which may occur. * * *

In general, however, the symptoms shown by trees affected with illuminating gas are quite different from those arising from other causes which are likely to be active. Trees affected with gas are very susceptible to rapid disintegration. One of the first effects of poisoning in summer would be a yellowing and drying up of the foliage, and a greater or less defoliation of the tree, according to the degree of poisoning. The trunk of the tree is generally dark colored, indicating an absence of life; but this feature is not always present.

The occurrence of various species of fungi on trees affected by gas is rather conspicuous, since these fungi are often very numerous, and make their appearance soon after a tree has been injured; whereas on trees dying from other causes it is sometimes many years before the bark becomes covered with fungi. The sap-wood is often found to be discolored, and it has peculiar, characteristic odors which assist in a diagnosis. Sometimes, however, especially when the

tree is injured by gas in late summer, at which time the flow of sap is not so pronounced as in the spring, the odors of the wood are not so marked. * * *

There is considerable difference in the resistance of soils to gas. In gravelly soils we have known gas to travel 2,000 feet without any difficulty when the ground is frozen, and escape into the cellar of a house; whereas in heavier soils gas is more likely to be restricted to smaller areas.

Digging up and thoroughly airing the soil will generally overcome poisonous properties resulting from escape of gas, but where the escape has been long continued and the soil has become thoroughly charged with the poisonous compounds in gas the sweetening process is slow, and it will be some time before trees can be replanted on the soil with good show of success.

THE TUNA OR PRICKLY PEAR AS A FOOD FOR MAN.[a]

The prickly pear, Indian fig, Barbary fig, or tuna, for these and other names are applied to the fruit of varieties of Opuntia, a family of cacti, is eaten in large quantities in the warm countries where it grows, and is of some commercial importance outside its native region. In many of the northern fruit markets in the United States these fruits are fairly common in the late fall, the present supply coming almost exclusively from southern Europe. Tunas are common in the southwestern United States and are used as food to a considerable extent, but they are much more abundant and used to a much greater degree in Mexico. (Fig. 1.)

Recently published bulletins of the New Mexico Station and the Bureau of Plant Industry of this Department, by R. F. Hare and D. Griffiths, report an extended experimental study of the tuna and its uses as food, and discuss also the cultivation, harvesting, marketing, and storing of these fruits and related questions.

There are many varieties of Opuntias, including both wild and cultivated sorts, which yield edible fruits to which the name tuna is applied. The fruits vary in shape and color according to the species and the conditions under which they are grown. They are commonly from 1 to 3 inches in diameter and are usually pear-shaped or fig-shaped, though in some species they are nearly spherical, and weigh from an ounce to a half pound or more, and when ripe vary from a yellowish green to a dark purple color. All varieties have minute spicules arranged in bunches over their surface, about one bunch to every square inch in the better varieties, though in most species the spicules are more numerous. The fruits of most species have large spines also which correspond to those on the cactus plant, but they are much more delicate and usually fall off before the fruits are thoroughly ripe. A cross section shows that the fruit is covered

[a] Compiled from New Mexico Sta. Bul. 64; U. S. Dept. Agr., Bureau of Plant Industry Bul. 116.

with a thin skin or epidermis, beneath which there is a rind varying in thickness from one-eighth to one-half inch. Inside this is pulp or edible portion, in which are found embedded from 100 to 200 or more seeds, for, with a few exceptions, these fruits are characterized by a very large seed content.

The extended series of analyses of Mexican and New Mexican tunas reported by Hare and Griffiths show that they resemble other suc-

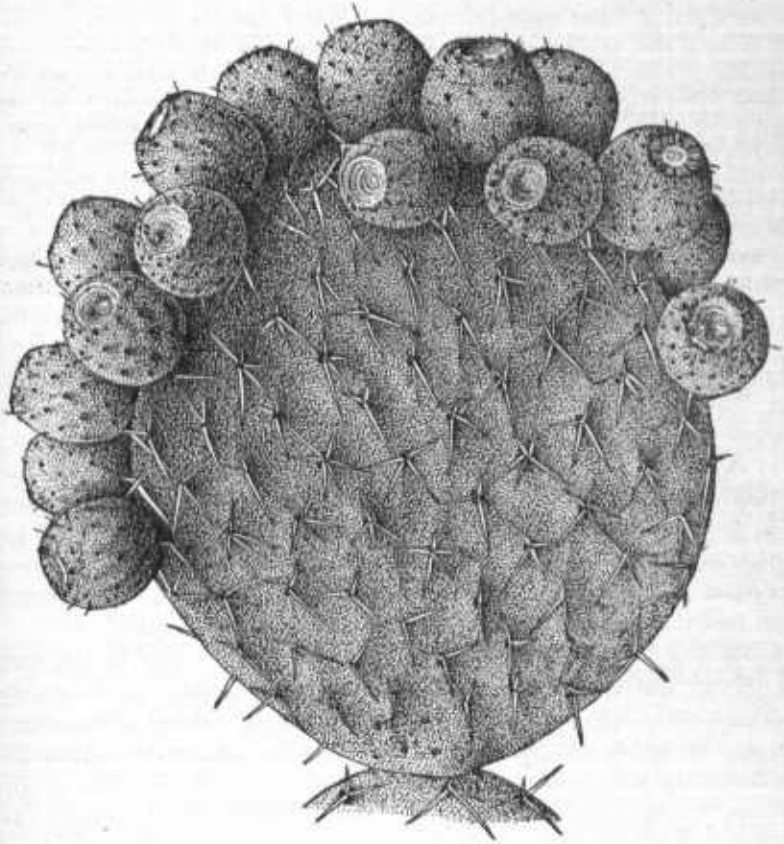

FIG. 1.—Tuna cardona, the most highly prized of all the Mexican tunas.

culent fruits in composition, the solid material constituting some 6 to 13 per cent of the total edible portion. The principal nutritive materials are sugars, 7 or 8 per cent being perhaps a fair average value. Small amounts of nitrogenous material, fruit acids, and ash are also present.

FRESH TUNAS.

In Mexico, where many varieties are eaten, some are considered more wholesome as well as more palatable than others. The harvest-

ing of wild and cultivated tunas is a matter of much importance, and the methods which are followed in Mexico are described at length by Hare and Griffiths:

> During the height of the season, when the fruit is cheapest, women appear on the markets each morning with huge baskets of them ready peeled. * * * Each purchaser is furnished with a tip of maguey leaf or a thorn of the mesquite with which to eat the pulps. * * * By far the greater amount of fruit is sold unpeeled. This is especially true during the season when fruits are not abundant, for less waste attends it. Sometimes the purchaser peels the fruit himself and at others he eats it as the vender or his attendant peels it for him. The process of peeling is simple, * * * the knife being run across the top and down one side to the base, when the pulp may be picked out easily. When fully ripe much of the rind of some species is consumed with the pulp. * * *
>
> On the whole it may be said that tunas are easily injured and consequently much care is necessary in handling them when they are intended for packing. They must also be well aerated in storage, which is true of all fruits. * * * Contrary to popular opinion, some tunas can be preserved in the fresh condition about as long as the common fruits of the temperate zone, if properly handled.

DRIED TUNAS AND TUNA PRODUCTS.

Tunas are dried in large quantities, the thin skin which covers the rind being first removed. White or yellow varieties are usually selected for drying, as they yield a more attractive product than the red. A number of other food products are also prepared from tunas, notably a thick sirup known as "Miel de Tuna," or tuna honey, a thick, paste-like mass known as "Melcocha," and a more solid paste known as "Queso de Tuna," or tuna cheese, which in appearance somewhat resembles old-fashioned apple marmalade. A fermented drink called "Colonche" is also made from these fruits.

In making the tuna honey "the peeled tunas are put in the kettles and boiled until the free seeds fall to the bottom. This occupies usually about two hours, fresh material being added from time to time as the water evaporates. The seeds are removed with a sieve and the sirup returned to the fire and boiled slowly for two or three hours more, or until it approaches the consistency of honey. It is then poured into wooden troughs, where it is thoroughly mixed with wooden paddles until completely cooled. After setting for twelve to twenty-four hours it is packed away in bottles or earthenware jugs. It may be kept about the same as molasses, and is said to remain in good condition indefinitely. After a time, however, it candies and becomes difficult to handle."

Melcocha and tuna cheese are made from peeled tunas from which the seeds have been removed, a seeder being used for the purpose.

The most palatable prickly pear growing in New Mexico, according to the authors quoted, is a variety with dark-purple fruit and a brilliant red juice, and while it is not eaten very extensively fresh it

is used by the Mexican residents in considerable quantity in the manufacture of preserves. In studies which were made with a view to determine the best use of the brilliant-colored juice the pulp was evaporated to a thin paste constituting about one-eighth of its original volume without suffering any change in color.

This paste was used for coloring apple jelly and candy, and was found to serve admirably for the former purpose. Because of the danger or prejudice against the use of the coal-tar dyes, it may have some value commercially as a vegetable coloring matter. Candy colored by means of it lacked the brilliancy of that colored with coal-tar dyes, and it is doubtful if it could ever be very generally used for this purpose. The paste prepared in this manner had 51.6 per cent sugar, only 0.48 per cent being sucrose. By removing the sugar and insoluble solids from the material the coloring matter could probably have been concentrated to as rich a color as cochineal paste. * * * As to whether or not the fruits will ever prove of commercial value for the preparation of a coloring matter will, we believe, depend solely upon the yield per acre that can be obtained. This can only be determined by experiment.

As regards the value of tunas in general and the possibilities of their cultivation, Hare and Griffiths believe that conservative judgment based on observation and experiment "would pronounce many species of prickly pear to be decidedly susceptible to cultivation and highly productive of both fruit and forage under proper conditions of temperature and moisture."

It is also true that there are species which thrive under moderate extremes of heat; that, as a rule, they are adapted to conditions of periodical rainfall and thrive where the distribution of moisture is too irregular and uncertain for commonly cultivated crops; that the spines and spicules have been practically successfully eliminated from the plant body in valuable species but not from the fruit; that all of the so-called spineless forms concerning which we have definite knowledge are less hardy, especially toward drought conditions, than spiny natives; that it is quite probable that by persistent breeding and selection the spines and spicules may be more completely removed and the plant bred to withstand a greater degree of cold; that the plants can be fed together with more concentrated foods with profit; that the fruit is now, in its spiny condition, an important and highly prized ingredient in the diet of the poorer classes of Mexico and Sicily especially; and that highly prized products are prepared from the fruits; that the group is of sufficient economic promise to merit thorough investigation.

COOKING CEREAL FOODS.[a]

Cereal breakfast foods may be roughly divided into three groups: (1) Those like old-fashioned oatmeal which are not cooked at all in the process of manufacture, (2) those like flaked or rolled grains which are partially cooked at the factory, and (3) those which have

[a] Compiled from Connecticut Storrs Sta. Rpt. 1904, p. 180; Maine Sta. Bul. 118; Ann. Rpt. Ontario Agr. Col. and Expt. Farm, 32 (1906), p. 63; Jour. Soc. Chem. Indus., 26 (1907), p. 240.

been submitted to some special cooking processes, like browning or baking, and may be eaten without additional cooking. Sometimes the cooked or partially cooked foods are treated with malt, which, it is claimed, converts some of the carbohydrates into soluble forms.

Extended series of digestion experiments with cereal breakfast foods have been reported from the Connecticut, Maine, and Minnesota experiment stations and the Ontario Agricultural College, which warrant the general conclusion that these foods closely resemble different types of bread in digestibility as they do in composition, the breakfast foods from which the coarser part of the grain has been removed approximating white bread in thoroughness of digestion, while those sorts which retain the branny portions more closely resemble graham bread and whole-wheat bread.

The subject of composition and digestibility of these foods and related questions has been discussed in earlier Farmers' Bulletins.[a] It is generally believed that long-continued cooking renders cereal breakfast foods more easily and thoroughly digested. In experiments carried on by R. Harcourt at the Ontario Agricultural College it was found that the farinas were broken down and rendered soluble to a greater extent by cooking than the oatmeals.

Young men in good health served as subjects of digestion experiments in which cereal foods cooked for a short period, twenty minutes, were compared with those cooked for a long period, eight hours. "In order that the results might be strictly comparable, the same subjects were used in determining the digestibility of the meal cooked for the short and long periods. Different subjects, however, were used with each sample of meal. This was done to bring in as many conditions as possible." The average results of the experiments follow.

Average digestibility of rolled oats and wheat farina cooked for long and short periods.

Kind of food.	Organic matter.	Protein.	Fat.	Carbohydrates.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Rolled oats (cooked twenty minutes)	94.2	81.5	92.5	98.0
Rolled oats (cooked eight hours)	95.4	84.3	94.6	98.3
Wheat farina (cooked twenty minutes)	95.5	79.3	94.9	98.3
Wheat farina (cooked eight hours)	95.3	79.4	95.6	98.5

From the above results, it is evident that the length of time the meal was cooked did not very materially influence the percentage amount digested. It is, of course, possible that less energy may have been expended in digesting that which was cooked the longer time, but no figures could be procured on this point. It is, however, important that starchy foods be cooked sufficiently long to cause the rupture of the starch cells. Judging by results, this apparently was accomplished, at least, nearly as well in one case as in the other.

[a] U. S. Dept. Agr., Farmers' Buls. 237, p. 14; 249.

From all the data which are reported regarding composition, digestibility, and comparative cost of a number of kinds of cereal breakfast foods Professor Harcourt concludes that—

> It is evident that corn meal, rolled oats, and the farinas, especially if bought in bulk, are the most economical breakfast foods. It is, however, true that these foods do not agree with everyone and that the so-called predigested foods may be useful for those people who have difficulty in digesting starch. They may also have a place in a hurry-up breakfast, but it is evident that a curious name given to a much-advertised food does not indicate a high nutritive value, and the intelligent buyer who has to consider economy will hardly pass by the old forms of breakfast foods unless his own experience has actually demonstrated that these newer foods have a superior value.

SOME EXPERIMENTS IN SILAGE MAKING.[a]

The fermentation of silage entails more or less loss of material, but is commonly considered beneficial, as it develops flavors and softens plant tissue.

LOSSES IN THE SILO.[b]

The amount of material lost when green crops ferment in the silo has been frequently studied. In recent tests carried on at the Canada experimental farms with an experimental silo it was found that corn lost 15 per cent of its gross weight, a mixture of corn and rape 33 per cent, and rape alone 54 per cent. The material was placed in the silo in September and taken out in March.

STEAMED SILAGE.

Excessive fermentation produces silage with a high acid content, in addition to causing a large loss of nutritive material. The effect of checking extensive fermentation by treating silage with steam has been studied by A. L. Knisely at the Oregon Station for a number of years. The silos were filled in the usual way and steam generated in a boiler was passed through a pipe into the mass until it was thoroughly heated (twelve to fourteen hours at 20–40 pounds pressure) in case of silos 5 feet in diameter and 12 feet deep. Large as well as small silos were used. The method of piping to introduce the steam at the bottom and in the middle of the silos is shown in figure 2. The sugar, acidity, and moisture were determined in the fresh material and at frequent intervals when the silage was removed from the silo. In the case of cut vetch and whole and cut clover the acid in the fresh material before ensiling ranged from 0.18 to 0.27 per cent, calculated as acetic acid, and in the steamed silage when taken from the silo from 0.42 to 0.88 per cent. The sugar in the fresh material ranged from 1.36 per cent to 2.07 per cent and in

[a] Compiled from Delaware Sta. Rpt. 1903, p. 36; Oregon Sta. Bul. 72, Rpts. 1903, p. 34; 1905, p. 53; Canada Expt. Farms Rpts. 1904, p. 166.

[b] See also U. S. Dept. Agr., Farmers' Bul. 133, p. 31.

the silage from 0.93 to 2.08 per cent. In a test in which the silage was not steamed the fresh clover contained 0.18 per cent acid and the ensiled material 1.01 per cent, the proportions of sugar in the fresh and ensiled material being 1.82 per cent and 0.75 per cent. Another sample of ensiled clover, which was not steamed, contained 1.16 per cent acid. In later experiments the acidity of unsteamed silage of all kinds (corn, vetch, and clover) varied from 1.01 to 1.94 per cent, averaging 1.58, of steamed silage from 0.3 to 0.88 per cent, averaging 0.53 per cent. Steaming seems to be more effective in checking the acid fermentation in corn than in other crops.

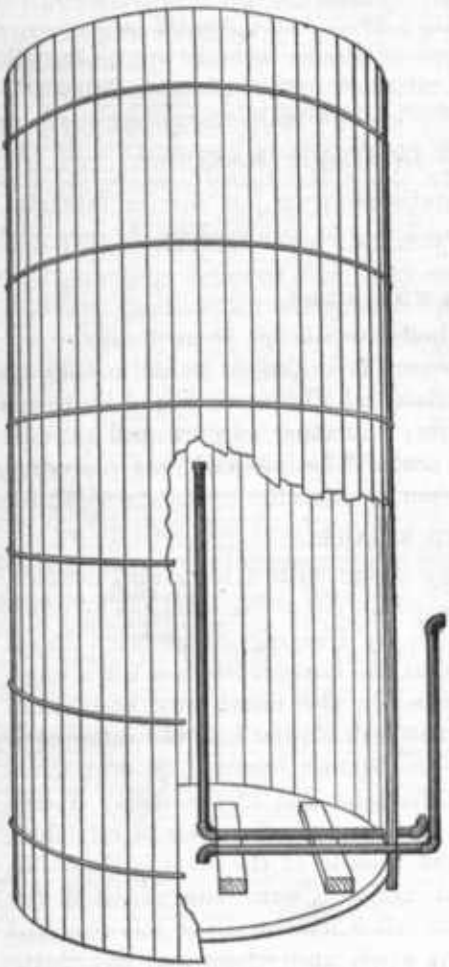

FIG. 2.—Method of piping for steaming silage.

In one of the tests of steamed silage immature corn fodder which had been touched by frost was used. Full analyses of the fresh and ensiled material are reported, the acid in the silage being determined at intervals of a week for about two months. The fresh material contained 0.18 per cent acid and 2.43 per cent sugar and the material when taken from the silo 0.48 per cent acid and 2.15 per cent sugar. For purposes of comparison a full analysis was made of ordinary corn silage. This contained 1.65 per cent acid and 0.49 per cent sugar. A comparison of the two materials led the author to conclude that the ordinary silage "underwent considerably more chemical or biological changes than did the steamed silage, these changes being indicated by the large increase in acidity and decrease in sugar." The steamed corn silage was fed to stock and was found to have suffered very little injury from the frost.

As regards steaming silage in general, the author considers that the "operation was quite beneficial and the steamed silage was much better than that which was not steamed. Stall-fed animals were able to eat without the least injury 50 to 75 pounds of this steamed silage per day."

SILAGE FROM CURED CORN FODDER.

At the Delaware Experiment Station A. T. Neale has studied the possibility of making silage from cured corn fodder, being led to undertake the work by the fact that formerly good results were obtained locally by feeding cut corn fodder which was packed into boxes, moistened with hot water, and allowed to stand for twenty-four hours. Concentrated feeds, such as cotton-seed meal, could be mixed with the mass and such a mixture used in the place of bran. The method is too inconvenient for general use, but it suggested the possibility of making silage from dried corn fodder by the addition of water and subsequent fermentation. When the experiment was tried, a rise of temperature was noted in the silo and the development of an aromatic odor, as in the case of green silage. It was found that young and old stock ate such silage practically without waste and that cows preferred it to dried shredded fodder.

It is a better and a safer mass to use with cotton-seed meal than dried fodder or hay. The meal adheres to the damp fodder, can not be separated from it by the stock, mastication is insured, and impaction of cotton-seed meal prevented. * * *

In this experiment the quality of the fermented product varied. Where the moisture content was normal, the aromatic odor above noted was present. No points of excessive moisture were found. Fodder in the bottom of the silo was not as moist as that nearer the top. In places channels had formed, through which the water, pumped upon the surface, had flowed, leaving masses of only partially moistened fodder, in which to a limited extent a musty smell and visible mold in extreme cases were noted. This was also the case in the product stored in immediate contact with the cemented lining of the silo, a condition also likely to exist in silage made from green cornstalks.

The fact that the fire risks were noticeably decreased by moistening the fodder corn was patent to all observers.

In connection with the Delaware work the loss of material from fermentation was calculated in making silage from dried corn fodder moistened with water. According to the data reported, "100 pounds of the fodder would lose 2.81 pounds of starch, or its equivalent, to produce through its complete fermentation the necessary heat to raise the temperature of the mass to 165° F., and this amount, 2.81 pounds, is just 6 per cent of the total dry matter of the fodder."

RECENT HORSE-FEEDING TESTS.[a]

Various problems concerned with horse feeding and management have been studied at the agricultural experiment stations, and such work has been summarized in earlier Farmers' Bulletins.[b]

OATS.

Of recent work, that reported by F. W. Taylor, of the New Hampshire Station, is of interest, as it has to do with the comparative value of light and heavy oats for draft animals. Three pairs of work horses of Percheron blood were used in the test, one in each lot being fed heavy oats for thirty days and the others light oats. During an additional period of thirty days the conditions were reversed. In every case 16 pounds of the oats—that is, 5 pounds in the morning, 5 pounds at noon, and 6 pounds at night—were fed with mixed hay of average quality ad libitum. All the horses were used for farm work, requiring average exertion and endurance. As shown by weighings taken twice a week, 1 horse lost on both light and heavy oats, 5 gained on heavy oats, and 4 gained on light oats.

The total gain or loss in any case was not material and was not much greater than the variation in weight from one day to another. The practical results of this experiment seem to indicate that, pound for pound, the light oats have nearly the same feeding value as the heavy oats. Although the heavy oats contain a higher percentage of protein, fat, and nitrogen-free extract and a less percentage of fiber than the light oats, it seems probable that the relative proportions of these constituents in the two grades are such that they are more easily and thoroughly digested. * * * The percentage of kernel, as would be expected, bears a close relation to the weight per bushel. It should be remembered that although the two grades are practically equal pound for pound they are not equal quart for quart, and that in feeding by measure, as is usually done, due allowance should be made for the heavy oats and a less quantity given. Since oats are bought and sold by weight instead of measure, there seems to be no gain made in buying the heavy oats at a much advanced price over the light oats.

The French investigator, Grandeau, states, on the basis of experiment and observation, that crushing oats increases their digestibility, and that crushed oats have been fed with satisfactory results for some years by a cab company in Paris and have effected a decided saving.

MOLASSES.

The possibility of substituting for oats a mixed feed made up of 60 per cent molasses, 20 per cent corn feed, and 20 per cent linseed meal was studied by H. van de Venne with army horses at Brussels,

[a] Compiled from Louisiana Sta. Bul. 86; New Hampshire Sta. Bul. 129; Utah Sta. Bul. 101; Breeders' Gaz., 48 (1905), p. 697; Centbl. Agr. Chem., 34 (1905), No. 12, p. 825; 2 Cong. Internat. Alliment. Ration. Bétail, 1905, Raps., p. 1; Jour. Agr. Prat., n. ser., 10 (1905), p. 777; Natal. Agr. Jour. and Min. Rec., 9 (1906), p. 1123; Soc. Alliment. Ration. Bétail, Compt. Rend., 10. Cong., 1906, p. 87.

[b] U. S. Dept. Agr., Farmers' Buls. 103, 133, 170, 222.

Belgium. Judging by the weight of the animals, he concluded that the normal ration made up of 12.13 pounds oats, 1.32 pounds bran, 6.61 pounds hay, and 4.41 pounds chopped straw was sufficient for their needs. When about half the oats was replaced with the molasses feed somewhat greater gains were made than on the normal ration. The molasses ration had no marked effect on the amount of water consumed.

Molasses was an important constituent of the above-mentioned ration, and this material is attracting considerable attention at the present time as a feeding stuff for horses and other farm animals.

According to W. H. Dalrymple, of the Louisiana Experiment Station, who has studied the question in the Louisiana sugar plantations, "the custom of feeding molasses to the work stock on our large sugar estates has been adopted in anything like systematic manner only within the past few years. Previously, and when the price was extremely low, quantities of the material were run into large iron troughs, and the mules allowed free access to it; and, to some extent, this rather prodigal method still prevails. The true value of blackstrap as a food stuff has become more apparent of late years, however, and as the question of feeding economically has become one of considerable moment to our planters, it is being used more as an ingredient of the 'balanced ration,' and, as a rule, mixed with other concentrates."

The average consumption on 47 plantations in the sugar belt was found to be about 10 pounds per head per day, and the range, according to the statistics gathered, about 2 to 21 pounds. A gallon of blackstrap molasses weighs on an average 12 pounds. Chopped hay, pea vines, alfalfa, and occasionally green cane tops, and some concentrated feed are commonly mixed with the molasses and the whole fed in three portions. It is desirable to begin with small amounts of molasses when this material is introduced into a ration.

The data collected are in accord with the generally accepted view that molasses, where it is available at reasonable prices for feeding purposes, constitutes a wholesome and easily digested, as well as an economical, constituent of a ration for draft animals. "It would seem that the somewhat general impression that molasses, from any source, is unduly laxative, must have been based upon the effect produced by the by-product from the beet factory, and not sugar-cane molasses, as there is abundant evidence in our own State of the harmless effect of blackstrap, so far as a purgative action is concerned."

Molasses, as everyone knows, owes its nutritive value largely to the sugar which it contains. A French investigator, who studied the feeding value of beet molasses, states that experimental evidence shows that sugar did not appreciably diminish the digestibility of the nutrients of a ration when the amount fed to horses was equal

to 5 or 6 pounds per 1,000 pounds live weight. Sirup and molasses, however, when fed in smaller quantities decreased the digestibility of the ration, a fact which is explained by the laxative properties of the alkaline salts in beet molasses. The general conclusion drawn from the experimental evidence summarized by this investigator, however, was that beet molasses is a wholesome and hygienic feed when the amount consumed per day does not exceed 6 or 8 pounds per horse.

SUCCULENT FEEDS.

A number of investigators have recently studied succulent feeds for horses. R. W. Clark, of the Utah Station, states that 16 to 20 pounds of well-fermented, solid sugar-beet pulp was fed to horses experimentally for six or eight weeks and no irregularity in the health of the animals was noted which could be attributed to the pulp.

In a test covering two periods of twenty-eight days each, made with 4 work horses, alfalfa, oats, and sugar-beet pulp were fed in comparison with a ration without pulp. Little difference was noted in the effect of the two rations, the horses on pulp losing on an average 6 pounds and those without pulp 2 pounds per head. "The above results indicate that beet pulp can be fed to horses without detriment to their health, though the amount consumed (9 pounds per head daily on an average) was small. The horses on pulp received 1.5 pounds less of grain per day than those that received no pulp, the amount of hay fed being the same in each case. The animals in each lot did equally well, and whether or not 9 pounds pulp is equal to 1.5 pounds oats when fed as in this experiment, awaits further demonstration."

It is stated that for several years colts have been allowed access to sugar-beet pulp at the factory where the test was made, and in no instance, so far as can be learned, has any trouble arisen from feeding it.

Jerusalem artichoke tubers have at various times attracted considerable attention in the United States as a feeding stuff for farm animals.[a] Having noted that the peasants in southern France are in the habit of feeding Jerusalem artichoke tubers to work horses, a French investigator recently studied the value of this material with draft animals and obtained satisfactory results. In his opinion, not over 13 quarts should be fed. The artichokes, it is stated, should be mixed with crushed grain and 11 to 16 quarts of chopped hay, which will absorb the moisture. When artichokes were thus substituted for barley or oats for one hundred days no unfavorable results were noted.

In Natal corn silage has been tested with satisfactory results for army horses. The daily ration of horses running in paddocks con-

[a] U. S. Dept. Agr., Farmers' Bul. 73, p. 92.

sisted of 4 pounds of chopped corn silage, 2 pounds of alfalfa or forage, a few pounds of crushed corn, and an ounce of salt. "From the first they liked the ensilage, and did remarkably well on it. Many horses not doing well before showed improvement. The droppings were of a particularly healthy nature. The stabled horses also had a few pounds mixed with other food—even those working—at their midday feed, and did well on it."

ALFALFA.

A recent publication of the Bureau of Animal Industry, by I. D. Graham, on the uses of alfalfa for farm animals, summarizes data on the value of this feeding stuff for horses as follows:

> Horses and mules "thrive on alfalfa pasture. * * * While * * * alfalfa is too rich a food for mature horses unless used in combination with some other roughness, it is an excellent feed for young horses, as it seems to contain just the elements necessary to develop bone, muscle, and consequent size. Caution should be used, however, in feeding alfalfa to horses, particularly if they have not been accustomed to it. Like other concentrated feeds, it seems to stimulate all the physical processes to such an extent that various disorders of the digestive system may appear. This is particularly noticeable in the urinary and perspiratory glands. * * *"
>
> When alfalfa is fed to horses in considerable quantity the grain ration must be proportionately reduced and an abundance of other roughness furnished. When horses have attained a mature age and it is desirable to change from other hay to alfalfa, this change must be very gradual, and the alfalfa selected for this purpose should be more advanced in growth at the time of cutting than that which is to be fed to cattle or sheep. As a general statement, very ripe alfalfa hay is the best to use for work horses and driving horses, while that prepared in the usual way—that is, cut when the field is about one-tenth in bloom—is better for the colts. In any event, horses that are fed alfalfa hay must be given abundant exercise.

SUPPLEMENTS TO CORN IN HOG FEEDING.[a]

Corn must necessarily be used more freely than any other concentrated feed for hogs in the corn belt, as is pointed out in a recent bulletin of the Iowa Station, because if properly used it is especially well adapted to hog feeding and can usually be marketed as pork to the very best advantage. It is, however, becoming generally recognized that so far as health, thrift and rapidity of gain are concerned, corn alone, at least in dry lot feeding, does not give as satisfactory results, particularly with growing hogs, as corn combined with some other feed richer in protein. Wheat shorts is commonly considered the best supplementary feed for young hogs, but a number of other common feeding stuffs which contain large quantities of protein are on the market, and the experiments carried on at the Iowa Station were

[a] Compiled from Iowa Sta. Bul. 91. See also Farmers' Buls. 169, p. 29; 276, p. 21.

undertaken with a view to studying the merits of some of them. It is evident that if a small reduction per hog in the cost of feeding can be effected by the use of such feeds the aggregate gain will be very large.

Corn alone, and with varying proportions of ground barley, wheat shorts, meat meal, and tankage, was compared in the tests with hogs which are reported by W. J. Kennedy and E. T. Robbins. The relative merits of dry lot as compared with pasturage and timothy and clover pasturage were also studied, especially with reference to their importance in connection with the feeding of corn alone and with other feeds.

Four lots of 12 well-grown hogs each were used in the first test, comparing corn alone and supplementary feeds, and the gains made in 32 days on the several rations were as follows: Corn, 1.88 pounds; corn, barley, and shorts 2:1:1, 2.21 pounds; corn and meat meal 9:1, 2.68 pounds; and corn and tankage 9:1, 2.34 pounds.

When different amounts of meat meal supplementing corn meal were studied with 4 lots of 9 young pigs each, the average daily gain per head on the several rations was 1.16 pounds on corn meal alone, 1.75 pounds on corn meal and meat meal 7:1, 1.79 pounds on corn meal and meat meal 8:5:1, and 1.86 pounds on corn meal and meat meal 10:1.

The feed eaten per pound of gain in the above 2 tests ranged from 3.7 pounds with the mature hogs on corn and meat meal 9:1 to 5.57 pounds with pigs on corn meal alone. The gain was most expensive with the latter lot, costing 3.97 cents per pound, and was least expensive with the mature hogs fed corn meal, barley and shorts, costing 3.15 cents.

A comparison of dry lot feeding and pasturage and of the effects of supplementing corn by other concentrated feeds under these conditions was studied with 10 lots containing 10 hogs each at the beginning of the trial, the test as a whole covering 112 days. When corn and shorts 2:1 and 1:1, corn meal and meat meal 5:1, and corn meal and tankage 5:1 were fed with timothy pasturage, the average daily gain ranged from 1.12 pounds on corn and shorts 2:1 to 1.37 pounds on corn and tankage 5:1. In the case of the same rations fed without pasturage the gain ranged from 0.81 pound on corn and shorts 2:1 to 1.09 pounds on corn and meat meal. On corn and timothy pasturage alone the average daily gain was 0.92 pound per hog and on corn and clover pasturage 1.19 pounds. Considering all the lots the concentrated feed eaten per pound of gain ranged from 3.98 pounds with the lot fed corn and shorts 1:1 on timothy pasturage to 5.12 pounds with the lot fed corn and shorts 2:1 in a dry yard, and was on an average 4.29 pounds. The cost of a pound of gain ranged from 3.35 cents with the lot pastured on clover and fed corn

to 4.46 cents with the lot on corn and shorts 2:1 fed in a dry yard, and was on an average 3.92 cents.

In reporting these tests data are given regarding the shrinkage when slaughtering, and the profits are discussed at length on the basis of corn meal, meat meal, and tankage at different prices.

From a consideration of their results, the authors conclude that meat meal and tankage of similar composition are about equal pound for pound as supplements to corn in a ration for growing and fattening hogs and that both of these animal by-products are profitable adjuncts to corn and are more valuable for dry lot feeding than when pigs or hogs are being developed and fattened on pasture, especially if the pasture be composed of leguminous crops.

Growing pigs fed meat meal or tankage to the extent of one-sixth of their ration, and older hogs having these feeds to the extent of 10 per cent of their ration, with corn, ate more feed and made more rapid gains than those fed on any other combination, such as shorts, barley and corn, or shorts and corn, tested in these experiments. In dry lot feeding a ration composed of corn with either meat meal or tankage produced from 25 to 40 per cent faster gains on quite mature hogs, and from 50 to 60 per cent faster gains on younger hogs, than a ration of corn alone, and in every instance the number of pounds of feed required per 100 pounds gain was decidedly less with the mixed ration.

There was not very much difference in the results obtained when pigs of 137 pounds weight at the beginning of the experiment were fed corn with meat meal in the proportions of 7 to 1, 8.5 to 1, or 10 to 1. The proportion of 10 to 1 produced the most rapid gains and the greatest total profit, while the proportion of 7 to 1 required the least total amount of feed, but the greatest amount of meat meal, per 100 pounds gain. * * * Hogs fed on rations composed of corn and meat meal and corn and tankage were fully as acceptable to the buyers, both from the standpoint of the quality and condition of the flesh, as those fed on any of the other rations tested.

As regards the value of shorts as a supplement to corn, a ration of these 2 feeds 1:1 produced larger gains with less feed per pound of gain when fed to pigs on pasturage or in dry lots than a ration of corn and shorts 2:1.

"The advantage of the larger proportion of shorts was much more in evidence in the dry lot feeding than in pasture feeding. For feeding pigs on pasture with feeds at the prevailing prices a ration of corn alone produced 100 pounds of gain at a smaller cost than a ration of corn and shorts. The corn and shorts ration, however, yielded somewhat the greater total profit, due to the more rapid gains produced from the use of the same."

With respect to barley, the authors note "that a ration composed of corn 2 parts, barley 1 part, and shorts 1 part produced 100 pounds of gain at fully as low a cost as the rations containing meat meal or tankage in conjunction with corn. At the prevailing market price,

barley proved to be an economical feed when combined with corn and shorts for finishing hogs for market."

When average results for pasturage and dry lot feeding were compared "there was less variation in the amount of concentrates required to produce 100 pounds of gain on pasture than in the dry lot feeding. With the pigs on timothy pasture, the most evident effect of increasing the amount of protein of the concentrated feed up to a point where the balanced ration was fed was to increase the amount of feed consumed and produce correspondingly larger gains."

In general, in dry lot feeding the most rapid and economical gains were obtained from those rations which contained a much larger proportion of protein to carbohydrates and fats than is found in corn.

The price which feeders can afford to pay for supplementary feeds, rich in protein, to add to the corn ration for the purpose of balancing the same, must be regulated by the percentage of digestible protein contained in them and the market price of corn. When corn is high in price, supplementary feeds, as a rule, can be had at prices which will not prohibit their use; but when corn is very low in price, the feeder will very likely lose a portion, if not all, of his profits in pig feeding through the purchase of supplementary feeds. * * * With feeds at the usual prices, it is an easy matter by their judicious selection to so supplement corn as to add 5 to 15 cents per bushel to the profit from feeding corn, thus effecting a reduction of 50 cents to $1 on each 100 pounds gain in weight by the pigs.

TANKAGE FOR HOGS FOLLOWING CATTLE.[a]

In regions of the West where cattle are fed in large numbers on corn, many hogs are fattened upon the undigested grain found in the droppings of the cattle. B. E. Carmichael, of the Ohio Station, found that of 45 feeders in that State, of whom he obtained definite information, 35 "either used no feed besides that which was not digested by the steers or else gave corn in addition. Since corn is the chief grain used for fattening cattle, it follows that the hogs which depend solely upon the undigested grain in the steers' droppings must be confined to a ration made up almost exclusively of corn. Even if, in addition to corn, other concentrates richer in protein and ash than is corn are fed to the steers, the corn in the droppings is much more readily found, and the benefit derived by the hog from the feeds other than corn is not very great, although it is believed that some benefit may be derived." The feed of the hogs is therefore deficient in protein and ash.

The Ohio Station undertook a series of experiments to determine whether or not the prevailing practice can be improved by supplying a feed comparatively rich in protein and ash to hogs that follow fattening cattle. In these experiments six lots of steers, seven head in

[a] Compiled from Ohio Sta. Circ. 73.

each lot, were fed upon two different rations—three lots upon each ration, lots 1, 3, and 5 receiving shelled corn, cotton-seed meal, corn stover, mixed hay, and corn silage; lots 2, 4, and 6 receiving shelled corn, cotton-seed meal, corn stover, and mixed hay.

The three lots last mentioned received more corn and more dry roughage than did the lots first mentioned, on account of not receiving silage, which, of course, contained both grain and roughage. All lots of cattle received the same amount of cotton-seed meal daily per steer.

During the first part of the experiment three hogs were put with each lot of cattle; later these hogs were replaced by a thinner lot and four hogs were placed with each lot. The first set of hogs was under experiment for 63 days, the second set for 56 days.

Not a large enough number of hogs was used in any of the lots to eat all of the grain that passed through the steers, although the amount left was in no case great. No corn was fed to the hogs, and, as the cattle feed racks were so constructed as to prevent the grain being thrown out, the hogs secured no grain except that which appeared in the droppings from the steers. * * *

The supplementary feed used in this test was digester tankage, a packing house by-product, of which the hogs in lots 1 and 6 received one-third of a pound daily per head after they had become gradually accustomed to it. The hogs in lots 3 and 4 received no feed other than that obtained from the droppings from the cattle. All lots were kept supplied with a mixture of ashes and salt. It is of interest to note that the lots fed tankage cared less for the ashes and salt than did the other lots.

The tankage was fed in the form of a thin slop, once daily. It may be very conveniently fed in this manner, and was greatly relished by the hogs; in fact, they exhibited an almost ravenous appetite for it.

The gains made by the tankage-fed hogs were more than one-half (52 per cent) larger as well as cheaper than those receiving no tankage.

The results show that a decided advantage resulting from the feeding of the tankage is that fewer hogs are required to consume the droppings from a given number of cattle, and that less time is necessary to produce a given amount of gain, thus both reducing the amount of money tied up in hogs and permitting a more frequent turning of the money.

Aside from these considerations, feeders will readily appreciate the fact that fewer hogs and a shorter feeding period would greatly lessen the liability to loss from cholera. Any method of feeding or management of live stock which makes it possible to reduce the number of animals necessary to furnish a given amount of product, or to cheapen in any other way the cost of production, is worthy of consideration by stockmen. It seems certain that the use of such supplementary feeds as are suggested in this circular will greatly increase the profits from hogs that follow cattle.

While, on account of its cheapness as a carrier of protein and ash and convenience for feeding, digester tankage was used in the work reported herein, it is believed that other feeds, such as linseed oil meal, soy beans, skim milk, buttermilk, or middlings would greatly increase the efficiency of the "cattle hog" in making economical gains. Feeders need, however, to exercise keen discrimination in the purchase of feedstuffs, for there is a likelihood of a heavy demand

for certain feeds, making it possible for the manufacturers to raise prices beyond the amount justified by the feeding value.

While further work is needed "to determine what feeds are best suited for this purpose, and in what amounts they should be fed," sufficient has been done "to show that hogs following cattle are often not supplied with the ration best suited for the production of the greatest gains."

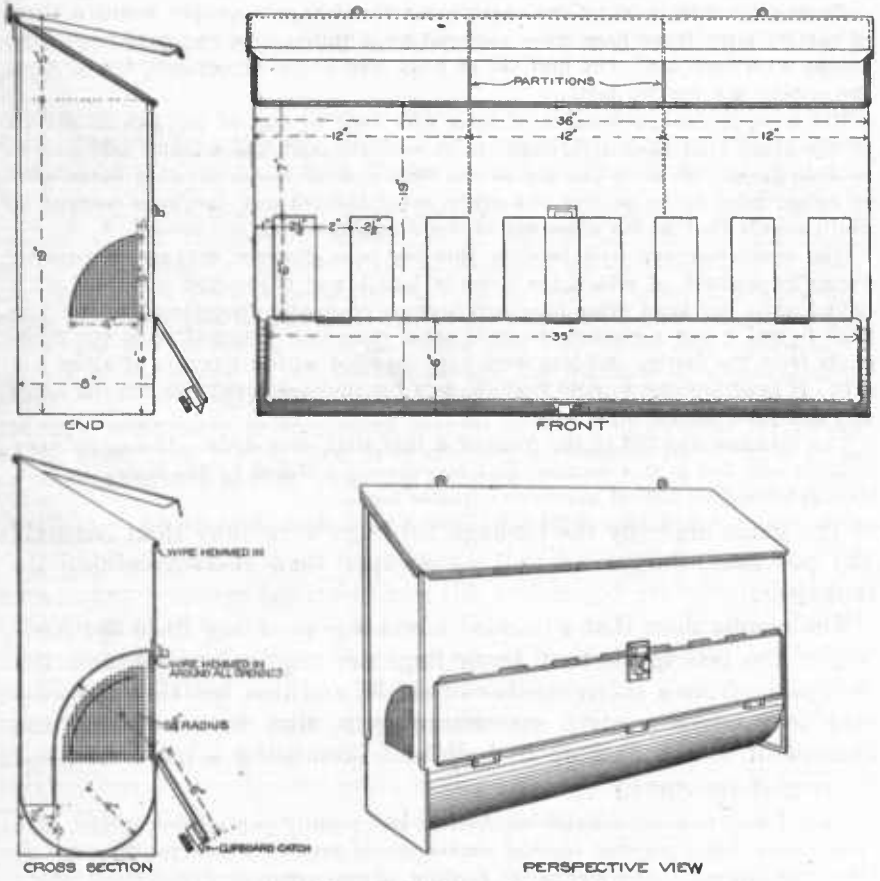

FIG. 3.—The New York feed hopper.

HOPPERS FOR POULTRY FEEDING.[a]

In the dry feeding of poultry, which is attracting considerable attention at the present time,[b] a hopper or some similar device for supplying feed is essential. Hopper feeding, according to J. E. Rice and R. C. Lawry, of the New York Cornell Station, saves labor, guards against underfeeding, and makes the keeping of fowls in large

[a] Compiled from New York Cornell Sta. Bul. 248.

[b] See also U. S. Dept. Agr., Farmers' Bul. 244, p. 25.

flocks less objectionable because it avoids crowding, which is likely to occur when considerable numbers are fed a wet mash.

Experiments which have been conducted at the New York Cornell Station indicate "that for young fowls of the laying varieties, kept for commercial egg production, the feeding of a dry mash in a feed hopper which is accessible at all times during the day is to be recommended."

Whether the same system of feeding will prove as satisfactory with old fowls of the laying varieties or with young fowls of the general-purpose or meat varieties, we have not yet determined by actual comparative test. Nor has it been proved that the system can be used with safety with breeding fowls. This is a vital consideration. The ultimate test which will decide whether or not the hopper feeding of dry mash will be of universal application to the feeding of fowls, will be the effect on the vigor of the offspring. It is too early yet to decide this point. Many practical feeders, however, conclude from an extended experience that the breeding fowls having constant access to dry mash will not suffer in health from overeating or lack of exercise. We feel certain at this time that hopper feeding when properly employed has genuine merit and will become an established practice. To be successful, however, it must be adapted to suit the various breeds and other conditions as to age, season, and environment.

The authors have devised a hopper for use in the dry feeding of poultry which has been tested at the New York Cornell Station. It consists of a galvanized-iron box, having several compartments, with hinged cover, and on the front openings through which the feed can be reached by the poultry. A curved false bottom separates the upper or storage chamber of the hopper from the trough in the lower part and is arranged so that feed falls in small quantities into the trough. Figure 3 and the following quotation from the bulletin referred to explain the construction of this hopper:

The feed hopper which is used for feeding dry meals, meat scraps, or grain "is made of No. 26 galvanized iron, is 36 inches long, 24 inches tall, and 8 inches wide, divided into three compartments 12 inches wide, and will hold about 60 pounds of meal or 100 pounds of grain. It is built with a slanting top and has a door on the front that hinges up from below to close the opening when it is desired that the fowls should not eat. It is the outcome of a long series of experiments and is the only hopper of a large number tried at the station plant that will not waste feed and yet does not clog. The fact that it has a door to close and that it is made of galvanized iron makes it entirely rat proof. It is placed on a platform 5 inches tall that projects outward 6 inches in front to prevent the litter from being scratched into it. It has been found that one catch in the center of the door is more satisfactory than the two catches." The cost is about $4.

Recent experiments at New York Cornell Station have shown that lime and grit are required at all times by fowls for the best results as regards health and production. It is essential, therefore, that fowls should have access to cracked oyster shells or equivalent material at all times, and it seems also desirable that some other grit and perhaps charcoal should be provided. For this purpose a grit hopper was devised by the authors, which is large enough to make frequent filling unnecessary and is so constructed that it will keep clean and will not clog or waste. It is very similar in construction to the feed hopper described above, except that it is open above the trough instead of closed in. According to the authors, the cost of the hopper, which is made of galvanized iron, should not exceed $1. Figure 4 shows the appearance of the hopper and its method of construction. The rounded back and the overhanging lip in front prevent waste. The slanting top is also noticeable, as well as the eyes at the back, by which the hopper may be attached to the wall. The hopper illustrated is made in three compartments.

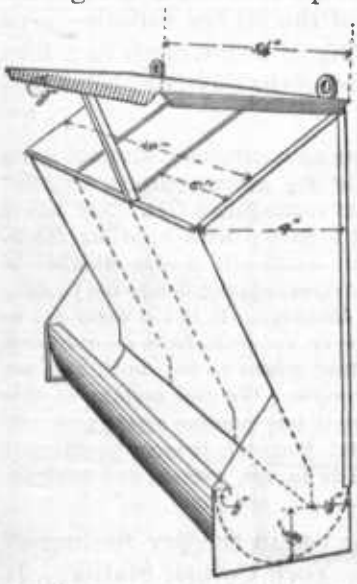

FIG. 4.—The new force-feed grit hopper, with three compartments.

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